Title:	RESONATOR TANK ENTRY PROCEDURE		
Procedure Number:	Revision:	Revision Date:	Page
88-PRO-022	REV. 3.0	1 June 2006	1 of 4

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1.0 PURPOSE

The intent of this procedure is to ensure that possible contamination from the Cyclotron RF Resonator Tank remains contained, and that the resonator tank is properly vented, flushed with fresh air, and tested as safe for entry, and the workers have proper training for work within the tank, and they have entry and burn permits as required before work begins.

This procedure must be used before entering the 88-inch Cyclotron RF Resonator Tank, which is a designated confined space. Entering the resonator tank is authorized by RWA 5027. The performance of this procedure must adhere to the requirements of RWA 5027.

2.0 QUALIFICATION

This procedure is to be performed only by a qualified Cyclotron staff member, who has been trained in this procedure, typically one of the engineering staff, or maintenance machinist, or a mechanical or electronic technician. This procedure may be performed only by personnel authorized by RWA 5027.

This procedure may be performed by the persons who have completed NSD1022 "Cyclotron RF Resonance Tank Entrance Procedure" training. The EH&S Training Reports database may be checked to find the names of the persons that have completed the required training for this procedure. Only workers who have completed the EH&S0275 "Confined Space Hazards" training may enter the resonator tank. Always use the buddy system. Never enter the resonator tank without a trained co-worker standing by outside the tank

3.0 HAZARD REVIEW

The performance of this procedure may subject personnel to the following potential hazards:

Radioactive Contamination:

Hazard: There may be radioactive surface contamination present on the resonator tank surfaces.

Mitigation: The Radiation Control Technician (RCT), or an EH&S radiation safety monitor, must survey these surfaces to determine the level of removable contamination. The RF tank is controlled by the RCT as a contaminated area. The personnel entering the RF Tank wear sufficient personal protection equipment (PPE) to control their exposure to contamination. The LBL ALARA (As-Low-As Reasonably-Achievable) Policy for personal radiation exposure applies during the performance of this procedure.

Crush Hazard:

Hazard: When someone is entering the RF tank the RF panels could move and potentially injure the person in the RF tank.
Mitigation: The RF panels motive power, the ALCW system supply water valve, is shut and LOTOed. As part of this procedure the RF panel full travel motion is checked (Step 4.2.5) and the panel motion system will need to be operational. When the RF panel motion operational check is completed the panels must be positioned as needed for the maintenace work and then the motion system must be disabled by LOTO before RF tank entry is allowed (Step 4.2.7).

Confined Space Hazard:

Hazard: The RF tank is a confined space and entry into the RF tank could result in personnel being subjected to oxygen deficient environment.
Mitigation: The RF tank and the Cyclotron must be vented. A confined space permit is required for entry into the RF tank. The oxygen level in the RF tank must be 19.5% or higher before entry is allowed. The RF tank air must be cleared and must be tested and found to have adequate oxygen levels before the permit is issued.

Electrical Hazard:

Hazard: The RF tank recieves the high power RF energy from the Final Power Amplifier. This is an electrical hazard that must be removed.
Mitigation: The RF high energy power system is LOTOed off at the 12kV breaker, GE50. This prevents the RF system from delivering any power to the RF tank.

4.0 PROCEDURE

4.1. PREPARATION

4.1.1. Pre-work planning.
Before proceeding with this procedure there must be a pre-work meeting with the work supervisor and the people performing the work to map out the work scope and safety concerns. There must be a RCT present to begin this work and provisions must be made to issue a confined space permit.

4.1.2. Prepare to enter the RF tank.

4.1.2.1. Electrical preparation: Before beginning any work in the resonator tank, the Cyclotron must be shut down, and the 12 kV breaker must be opened. Have the Building 88 Electrician, or a HV-trained, and authorized, engineer or technician, switch off Circuit Breaker ADF-2-88 on the Substation (at Cabinet GE-50), and apply grounding hooks to the Modulator and RF FPA. LOTO the 12 kV breaker, GE 50. Remove the electrical cables for ion gauge IG-02 at the south door and for IG-03 at the north door. Remove the cables to the leak detector mounted on the north door. Disable the Dee Trimmer Capacitor drive by unplugging the AC power for the Dee Trimmer Servo Amplifier, at the quad receptacle below the south door of the resonator tank.

4.1.2.2 Vent the RF tank: The resonator tank must be vented to atmospheric pressure before starting this procedure. The operations staff will vent the Cyclotron. Unbolt both resonator tank doors by removing all socket head screws, but two for each door. Do not open the doors until the RCT is ready for the doors to be opened. Verify the dry nitrogen fill hose is not connected on the north side of the tank.

4.1.2.3. Radiological Control preparation:. Have the RCT perform a survey, especially for loose contamination, of the resonator tank door area, and record the survey in the Vault Logbook, before opening any doors or ports. Paper the floor in front of the north and

south resonator tank doors as per RCT instructions. Post the area as a Radiation and/or Contamination Area, prepare stanchions, signs, and rope barriers as per RCT instructions. Gather enough radiation worker suits, or lab coats and booties, and rubber gloves to complete the anticipated work. Set up a radiation waste container at the boundary

4.2. RF TANK ENTRY PROCEDURE

4.2.1. Crack open the doors so that an RCT from ES&H, can check to take swipes to check for loose contamination in the resonator tank or the doors.

4.2.2. Once determined safe from a radiation safety standpoint, fully open both doors.

4.2.3. An EH&S Industrial Hygienist, or a trained, authorized staff member, must survey the resonator tank atmosphere with a portable Oxygen meter, and issue a *Confined Space Entry Permit* before anyone can enter the tank. Only those with confined space training, radiation worker training, and resonator tank entry training (RWA 5027) may enter the resonator tank.

4.2.4. Before entering the resonator tank, ensure there is no standing water inside the tank, and there are no water leaks into the tank.

4.2.5. RF Panel Motion Check: While inspecting the hinge action, the bearing actions, and the play of the water hoses, open the resonator panels to the full open (low frequency) position. Then, move the panels to the full closed position (high frequency), and repeat at least once.

4.2.6. Set the position of the resonator panels as needed to work in the tank.

4.2.7. Close the RF PANEL MOTION WATER VALVE in the pit so the panels cannot be moved. Apply a lockout device to the valve handle and tag it.

4.2.8. When all the above requirements are fulfilled it is safe to enter and work in the tank as required.

4.2.9. Under the supervision of the RCT access is allowed to the RF Tank to perform the required maintenance work.

4.2.10. Conduct an RF resonator tank inspection, including, at minimum, the following specific items:

A. Burned cracked or loose RF hinges on all the hinge points of all six resonator panels, and the trimmer capacitor rotor.
B. Condition of the flexible cooling water lines for the moveable RF panels: support chain integrity, covering braid condition, especially at the ends.
C. Arcing or spark damage on capacitor plates or the RF panels or hinges, or in the RF coupling capacitor.
D. Pronounced discoloration on any of the copper surfaces in the resonator tank, - indicating possible local heating.
E. Foreign material such as dust on Dee stem, floor, panels and the diffusion pump gate valves.
F. If it will be necessary to do any welding, hard soldering, or grinding, contact the business number of the LBNL Fire Department to obtain a *BURN PERMIT* before starting work.

4.2.11. When inspection and maintenance work is completed, check that the tank is free of any tools or other foreign objects. Verify the RF panels will be able to travel without being blocked.

4.2.12. Inspect the double o-ring seals of both doors to ensure the o-ring seal is not damaged (the o-rings are used dry). Check that all cables and hoses are clear of the door's mating surfaces. Close the RF tank doors, then replace and tighten the screws.

4.3. RETURN TO NORMAL OPERATION

4.3.1. Remove the RF PANEL MOTION WATER VALVE lockout device and open the water valve when work is completed. Verify the RF panels operate smoothly to full open and fully closed positions.

4.3.2. Restore the dry nitrogen fill line, and the electrical connections to Ion Gauge IG-02 on the south door and for Ion Gauge IG-03 and the leak detector at the north door of the Resonator Tank.

4.3.3. Plug in the AC power cord for the Dee Trimmer Servo system at the AC quad receptacle below the south door of the resonator.

4.3.4. With all locks removed, the B88 Electrician, or a HV-trained and authorized engineer or technician, may remove grounding hooks and switch on Circuit Breaker ADF-2-88 on the Substation (at GE-50) to restore 12-kV DC power.

5.0 RECORDS

Records generated by compliance with this procedure are to be in compliance with RPM, Section 1.18, Records Management.

Records generated through implementation of this procedure consist of entries recorded in the Cyclotron Vault Logbook, located at the Cyclotron Vault West Door.

Additional records generated through implementation of this procedure consist of the issuance of a Confined Space Entry Permit, maintained by EH&S Division and completion of the 12 kV LOTO procedure, maintained by the EM shop.

6.0 REVIEW OF PROCEDURE

Under the guidelines for DOE Order 420.2B, this procedure will be reviewed at least once every three years, or sooner if changes occur that may impact the appropriateness or implementation of this procedure.

REVISION HISTORY

8 July 1996: Issued as V 1.0 to formalize procedure and include the need for an EH&S Confined Space Entry Permit, and the EH&S Confined Space training course requirement.

20 Nov 2003: Reviewed and updated as V2.0 to update the title page, to change the 12-kV switching requirements, and Lockout-Tagout requirements.

1 June 2006: 88-PRO-022 was updated and approved as V 3.0 to reflect current operating practices and implementation.

7.0 GLOSSARY

ALARA Policy: The LBL ALARA (As-Low-As Reasonably-Achievable) Policy for personal radiation exposure. For the Laboratory ALARA policy see LBL Publication 3000 Section 21.3: ALARA Program at Berkeley Lab.

OSHA: Occupational Safety and Heath Act, the United States (federal) and California safety guidelines for on the job safety.

RF Panels: Hinged movable copper panels, approximately 4 x 12 feet, three above the Dee stem, and three below, used to bring the resonator tank to radio frequency (RF) resonance at the Cyclotron operating frequency.

8.0 REFERENCES

1. LBNL Publication 3000, **Health and Safety Manual**, Chapter 4, Specific Workplace Hazards, *Confined Spaces*.

2. LBNL Publication 3000, **Health and Safety Manual**, Chapter 18, *Lockout – Tagout.*

3. LBNL Publication 3000, **Health and Safety Manual**, Chapter 21, *Entry Control Program*.

4. EH&S RWA 5027- Radiation Work Authorization to work inside the Cyclotron Vacuum envelope.

5. DOE Order: DOE O 420.2B, *Safety of Accelerator Facilities*

9.0 ATTACHMENT

Attachment A is a checklist for this procedure. Changes to the checklist do not warrant a revision of the procedure.

RESONATOR TANK ENTRY PROCEDURE CHECKLIST

PREPARATION

[ ] 1. Pre-work planning, discuss work scope, hazards and hazard mitigation.

[ ] 2. Prepare to enter the RF tank.

[ ] A. Shutdown the Cyclotron.

[ ] B. Electrical Preparations: 12kV breaker LOTO procedure complete, modulator and FPA grounded, Ion gauges disconnected, leak detector disconnected, trimmer capacitor drive AC unplugged.

[ ] C. Vent the RF tank. Unbolt both resonator tank doors. Do not open the doors until the RCT is ready for the doors to be opened.

[ ] D. Verify the dry nitrogen fill hose is not connected on the north side of the tank.

[ ] E. Radiological Control preparation: RCT make a radiation survey, then paper the floor in front RF tank doors, Post area as a Radiation Contamination Area and rope off area. Prepare area and collect sufficient PPEs. Set up a radiation waste container at the boundary

RF TANK ENTRY PROCEDURE

[ ] 1. Crack open the doors so that an RCT can take swipes.

[ ] 2. Once determined safe from a radiation safety standpoint, fully open both doors.

[ ] 3. Survey RF tank with oxygen monitor and issue a *Confined Space Entry Permit.*

[ ] 4. Before entering the resonator tank, inspect for water or leaks.

[ ] 5. Move RF panels full open to full closed and inspect the hinge action, the bearing actions, and the play of the water hoses, and repeat at least once.

[ ] 6. Set the position of the resonator panels as needed to work in the tank.

[ ] 7. Close the RF PANEL MOTION WATER VALVE in the pit. LOTO the valve handle.

[ ] 8. Inspect the RF tank for the following specific items:

[ ] A. Burned, cracked or loose RF hinges on all the hinge points of all six resonator panels, and the trimmer capacitor rotor.

[ ] B. Condition of the flexible cooling water lines for the moveable RF panels: support chain integrity, covering braid condition, especially at the ends.

[ ] C. Arcing or spark damage on capacitor plates or the RF panels or hinges, or in the RF coupling capacitor.

[ ] D. Pronounced discoloration on any of the copper surfaces in the resonator tank, indicating possible local heating.

[ ] E. Foreign material such as dust on Dee stem, floor, panels and the diffusion pump gate valves.

[ ] 9. If necessary to do any welding, hard soldering, or grinding, obtain a *BURN PERMIT*.

[ ] 10. When work is completed, check that the tank is free of tools or other foreign objects.

[ ] 11. Inspect the door double o-ring seals of each doors, check that all cables and hoses are clear of the door's mating surfaces. Close the RF tank doors replace and tighten the screws.

RETURN TO NORMAL OPERATION

[ ] 1. Remove the RF PANEL MOTION WATER VALVE LOTO device and open the water valve when work is completed. Verify the RF panels operate smoothly to full open and fully closed positions.

[ ] 2. Restore the dry nitrogen fill line, and the electrical connections to ion gauges on the doors and the leak detector at the north door of the Resonator Tank.

[ ] 3. Plug in the AC power cord for the Dee Trimmer Servo system.

[ ] 4. With all locks removed, the B88 Electrician, or a HV-trained and authorized engineer or technician, may remove grounding hooks and switch on Circuit Breaker ADF-2-88 on the Substation (at Cabinet GE-50) to restore 12-kV C power.